WHAT IS CLAIMED IS:

1. An apparatus for mixing a first fluid with a second fluid, the apparatus comprising:

a fluid distribution portion comprising at least one tubular portion having an outer surface and an inner surface, the inner surface defining a first flow path for the first fluid,

a duct that defines a second flow path for the second fluid, the duct having an axial direction and a first and second transverse directions mutually distinct from the axial direction, the first and second transverse directions defining a plane through an axial location and containing a cross-sectional area of the duct,

a first fluid delivery system for supplying the first fluid to the fluid distribution portion

a second fluid delivery system for supplying the second fluid to the duct; the tubular portion comprising a plurality of orifices each forming a third flow path along which the first fluid can be injected into the second fluid within the duct; and

wherein the outer surface of the tubular portion comprising the orifices is positioned within the duct in the second flow path and the orifices when projected onto a plane containing the first and second transverse directions have an average spatial density of at least about 10,000 orifices per square meter of duct cross sectional area.

2. The apparatus of Claim 1, wherein the orifices have an average lineal density of at least 1000 orifices per meter length of the tubular portion.

3. The apparatus of Claim 1, wherein the orifices when projected onto a plane containing the first and second transverse directions have an average spatial density of at least about 100,000 orifices per square meter of duct transverse cross sectional area.

4. The apparatus of Claim 1, wherein the orifices have an average diameter less than about 80 micrometers.

5. The apparatus of Claim 1, wherein the orifices have an average diameter less than about 20 micrometers.

6. The apparatus of Claim 1wherein the orifices have an average diameter less than about 5 micrometers.

7. The apparatus of Claim 1, wherein the at least one tubular portion comprises a tube spiraled about an imaginary outwardly convex shape.

8. The apparatus of Claim 1, further comprising a flexible manifold for connecting the first fluid supply system to each tubular portion.

9. The apparatus of Claim 1, further comprising a support that is coupled to the distribution portion to support the distribution portion in the duct.

10. The apparatus of Claim 1, wherein the tubular portion comprises a plurality of tubular curvilinear sections extending in at least one of the transverse directions, whose flow paths are connected to at least one manifold that is connected to the first fluid supply system.

11. The apparatus of Claim 10, wherein the curvilinear sections are positioned sequentially downstream within the second flow path from each other.

12. The apparatus of Claim 1, wherein the tubular portion comprises at least one tubular member that extends in the axial direction and at least one manifold which connects the tubular member to the first fluid supply system.

13. The apparatus of Claim 1, wherein the tubular portion comprises at least one tubular member that extends in the first or second transverse direction, and are connected to at least one pair of manifolds at angles between 5 degrees and 175 degrees..

14. The apparatus of Claim 13, wherein the manifolds are angled with respect to each other.

15. The apparatus of Claim 13, wherein a differential pressure is applied to the first fluid between the two manifolds.

16. The apparatus of Claim 1, wherein the tubular portion includes a first portion that extends in the first transverse direction and at least the size of the orifices or the distribution of the orifices in the first transverse direction are configured so as to deliver a non-uniform amount of the first fluid with respect to the first transverse direction to the second fluid to achieve a desired transverse distribution of the first fluid in the second fluid.

17. The apparatus of Claim 16, wherein the tubular portion includes a second portion that extends in the second transverse direction and at least the size of the orifices or the

distribution of the orifices in the second transverse direction are configured so as to deliver a non-uniform amount of the first fluid with respect to the second transverse direction to the second fluid to achieve a desired transverse distribution of the first fluid in the second fluid in the second transverse direction.

18. The apparatus of Claim 16, wherein the first and second transverse directions are perpendicular to each other.

19. The apparatus of Claim 16, wherein the first transverse direction is radial to the axial direction.

20. The apparatus of Claim 16, axial direction wherein the transverse ratio profile of second to first fluid flows is non-uniform in at least one of the first or second transverse directions.

21. The apparatus of Claim 16, wherein the desired transverse distribution of the first fluid in the second fluid is a substantially uniform distribution of the first fluid in the second fluid.

22. The apparatus of Claim 1, wherein the tubular portion has a streamlined cross-sectional shape relative to the flow path of the second fluid.

23. The apparatus of Claim 1, wherein the tubular portion has an anti-streamlined cross-sectional shape.

24. The apparatus of Claim 1, wherein the tubular portion is formed from at least one thin walled sheet attached to a structural member and wherein the orifices are formed on the thin walled sheet.

25. The apparatus of Claim 1, further comprising a vibration generator that is configured to vibrate the tubular portion.

26. The apparatus of Claim 25, wherein the vibration generator vibrates the tubular portion in a direction that is generally perpendicular the axes of most of the orifices.

27. The apparatus of Claim 1, further comprising a high voltage power supply which is connected to a plurality of members selected from the group of the duct, one or more tubular portions, an axial electrode, a distributed electrode, and a peripheral electrode displaced from the outer surface of the tubular portion such that the high voltage delivered

creates an electric field about the outer surface of the tubular portion that modifies jets of the first fluid exiting the orifices.

28. The apparatus of Claim 27, wherein the mean magnitude of the applied high voltage is within a desired range sufficient to achieve a desired reduction in the cross sectional area of the jets and less than the voltage that would cause an arc.

29. The apparatus of Claim 27, wherein the fluctuating magnitude of the applied high voltage is within a desired range sufficient to achieve a desired oscillation in the jets and less than the voltage that would cause an arc.

30. The apparatus of Claim 1, wherein the tubular portion includes a wall having a plurality of thinner portions and wherein the orifices are configured through the thinner portions.

31. The apparatus of Claim 1, wherein at least some of the orifices have a longitudinal axis that is oblique to the longitudinal axis of the tubular portion.

32. The apparatus of Claim 1, wherein the first fluid comprises a liquid and the second fluid comprises a gas and at least a portion of the first fluid evaporates when it is injected into the duct so as to cool the second fluid.

33. A method of mixing a first fluid with a second fluid comprising:

providing a fluid distribution portion comprising at least one tubular portion having an outer surface and an inner surface, the inner surface defining a first flow path for the first fluid,

providing a duct that defines a second flow path for the second fluid, the duct having an axial direction and a first transverse direction and a second transverse directions perpendicular to the axial direction, the first and second transverse directions at an axial location defining a plane comprising a cross-sectional area of the duct,

positioning the at least one tubular portion in the duct such that it extends in a direction having a component in the first transverse direction;

providing a plurality of orifices on the at least one tubular portion, each orifice forming a third flow path along which the first fluid can be delivered into the second fluid within the duct;

providing a first fluid delivery system for providing the first fluid to the first flow path;

controlling a delivery pressure of the first fluid;

configuring at least one of the (i) the size of the plurality of orifices in the transverse direction, (ii) the linear density of the plurality of orifices in the transverse direction or (iii) the delivery pressure of the first fluid to deliver a non-uniform amount, with respect to the first transverse direction, of the first fluid into the second fluid to achieve a desired distribution of the first fluid in the second fluid in the first transverse direction downstream of the fluid distribution portion.

34. The method of Claim 33, further comprising

providing a second tubular portion having an outer surface and an inner surface, the inner surface defining a first flow path for the first fluid and including a plurality of orifices for delivering the first fluid from the first flow path to the second flow path; and

positioning the at least one tubular portion in the duct such that it extends in a direction having a component in the second transverse direction.

35. The method of Claim 34, further comprising configuring on the second tubular portion configuring at least one of (i) the size of the plurality of orifices in the transverse direction, (ii) the linear density of the plurality of orifices in the transverse direction, or (iii) the delivery pressure of the first fluid to deliver a non-uniform amount, with respect to the second transverse direction, of the first fluid into the second fluid to achieve a desired distribution of the first fluid in the second fluid in the second transverse direction downstream of the fluid distribution portion.

36. The method of Claim 33, wherein the first transverse direction is a radial direction with respect to the axial direction.

37. The method of Claim 25, wherein the first and second directions are orthogonal to each other.

38. The method of Claim 33, further comprising

providing a second tubular portion having an outer surface and an inner surface, the inner surface defining a first flow path for the first fluid and including a

plurality of orifices for delivering the first fluid from the first flow path to the second flow path; and

positioning the at least one tubular portion in the duct such that it extends in a direction having a component in the second transverse direction.

39. The method of Claim 34, further comprising configuring on the second tubular portion configuring at least one of (i) the size of the plurality of orifices in the transverse direction, (ii) the linear density of the plurality of orifices in the transverse direction, or (iii) the delivery pressure of the first fluid to deliver a non-uniform amount, with respect to the second transverse direction, of the first fluid into the second fluid to achieve a desired distribution of the first fluid in the second fluid in the second transverse direction downstream of the fluid distribution portion.

40. The method of Claim 33, wherein the desired distribution of the first fluid in the second fluid is uniform in the first transverse direction.

41. The method of Claim 33, further comprising adjusting a circumferetial orientation of the orifices on the first tubular portion in the first transverse direction to achieve a desired distribution of the first fluid in the second fluid in the first transverse direction downstream of the fluid distribution portion.

42. The method of Claim 33, further comprising:

providing a second tubular portion having an outer surface and an inner surface, the inner surface defining a first flow path for the first fluid and including a plurality of orifices for delivering the first fluid from the first flow path to the second flow path; and

positioning the second tubular portion in the duct such that it extends in a direction having a component in the first transverse direction and is adjacent the first tubular portion.

43. The method of Claim 42, further including controlling a jet penetration distance in the transverse direction between 10% and 200% of the spacing of the first and second tubular portions.

44. The method of Claim 42, further comprising controlling a jet penetration distance to be about proportional to the spacing of between the first and second tubular portions.

45. A method of mixing and exchanging heat between a first fluid and a second fluid, the method comprising:

providing a delivery member for a first fluid, the delivery member comprising tubular portions with a plurality of orifices;

providing a duct for a second fluid through, the duct having a duct axis and encompassing the orifices;

configuring a non-uniform transverse distribution of orifice sizes along at least one of a first direction transverse to the duct axis, and

controlling the differential ejection pressure between the first fluid within the orifices and the second fluid outside the orifices along at least a first direction transverse to the duct axis;

providing a non-uniform density in the transverse direction of the orifices on the delivery member,

delivering the second fluid through the duct; and

and delivering the first fluid through the delivery member to control the temperature of the second fluid exiting the duct.

46. The method of Claim 45 further comprising:

controlling the delivery temperature of the first fluid;

controlling the temperature of the duct to a desired level below the freezing temperature of the first fluid such that a desired portion of the first fluid solidifies within a desired portion of the duct length.

47. The method of Claim 45 further comprising:

controlling the first fluid temperature so as to evaporate a desired portion of the first fluid in the second fluid.

48. The method of Claim 47 further comprising: controlling the mean distribution of a measure of first fluid drop size in the first transverse direction.

49. A method of radiatively exchanging heat with a first fluid comprising:

providing tubular portions comprising numerous orifices within a duct;

configuring the orifices to have a non-uniform spatial distribution with respect to a transverse axis of the duct;

configuring the orifices to have a non-uniform size distribution with respect to the transverse axis of the duct;

delivering a first fluid to the tubular portions with a non-uniform differential ejection pressure with respect to the transverse axis;

controlling the temperature of the first fluid delivered to the tubular portions,

controlling the temperature of a wall of the duct, and

controlling the radiation flux from the duct wall to the first fluid being delivered from the tubular portions to the duct.

50. The method of Claim 49 further including

configuring a section of the duct wall to be desirably transparent to electromagnetic radiation,

transmitting electromagnetic radiation through the transparent wall section

configuring the tubular portions and orifices to deliver the first fluid across the transmitted electromagnetic radiation with a desired spatial distribution and drop size distribution

such that a desired portion of the transmitted electromagnetic radiation is absorbed.

51. The method of Claim 49, further comprising utilizing one or more of gallium, an alkali salt, or mixtures of alkali salts as the first fluid.

52. The method of Claim 49 , further comprising: positioning portions of the tubular portions in a plurality of sub-ducts and configuring the orifices such that the radiative view factor of the first fluid drops within the sub-ducts is within a range of 5% and 98% of that within a black body.

53. A method of mixing a first fluid with a second fluid comprising:

providing a fluid distribution portion comprising at least one tubular portion having an outer surface and an inner surface, the inner surface defining a first flow path for the first fluid,

providing a duct that defines a second flow path for the second fluid, the duct having an axial direction and a first transverse direction and a second transverse directions perpendicular to the axial direction, the first and second transverse

directions at an axial location defining a plane comprising a cross-sectional area of the duct,

positioning the at least one tubular portion in the duct such that it extends in a direction having a component in the first transverse direction; and

dynamically controlling the distribution of the first fluid into the second fluid with respect to the first transverse direction downstream of the fluid distribution portion by controlling the pressures at both ends of the fluid distribution portion.

54. The method of Claim 53, further comprising delivering a non-uniform amount of the first fluid into the second fluid with respect to the first transverse direction to achieve a substantially uniform distribution of the first fluid into the second fluid downstream of the fluid distribution portion.

55. The method of Claim 53, further comprising dynamically controlling the pressures at both ends of the fluid distribution portion in response to fluctuations in the flow of the second fluid in the duct.